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Title: Neutron Spectroscopy for NER Applications

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Neutron Spectroscopy for NER Applications

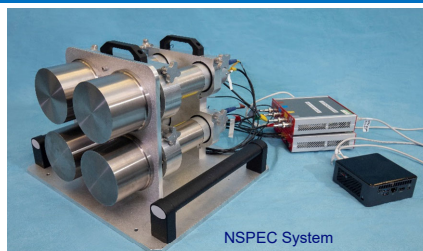


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Goals

- Single scatter fast (> 1 MeV) neutron spectroscopy (NS) presents a unique capability, under utilized by Nuclear Emergency Response (NER).
- Assess the range of applicability to NER scenarios. Includes automation methods
- Assess impact of attenuating materials

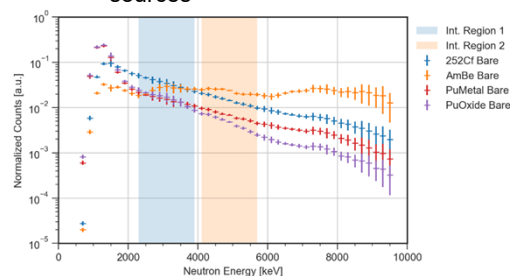
AmBe and **Pu Oxide** are clearly distinguishable using NS; Source ID is not impacted by moderators



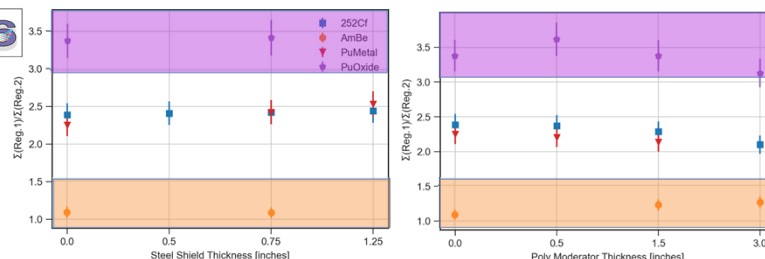
Analysis Methods

TOOLS TO QUICKLY DETERMINE THE SOURCE AND CONSTRAIN THE SOURCE STRENGTH

- Step 1: Two regions, relative ratios
 - enables isolation of the source type
- Step 2: Slope fit
 - Separate and identify spontaneous fission sources



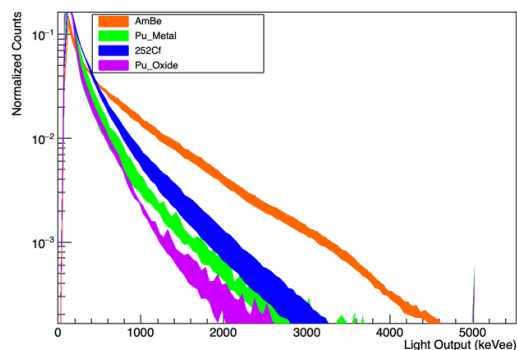
Unfolded Neutron Spectra, with Two Regions of Interest (ROI)



Relative ratios for ROIs for varying Steel (left) and Polyethylene (right) thickness

LABORATORY MEASUREMENTS

- Sources: AmBe, Cf-252, WGPu, and PuO₂
- Shielding: Bare, Steel (0.5", 0.75", 1.25"), Polyethylene (0.5", 1.5", 3.0")
- Chosen based on simulations in MCNP6.
- Analysis showed each source is unique, independent of shielding.



Measured light output with all shielding configurations for each source



Next Steps

POSSIBLE FIELDABLE TECHNOLOGIES

- Relatively insensitive to climate and temperature, calibrated quickly in-situ, and can be automated.
- Reduce size and weight
- Use of Silicon PhotoMultipliers (SiPMs) instead of PhotoMultiplier Tubes (PMTs).
- Future measurements likely include high-fidelity NER-like objects at NCERC.



IMPACT TO NER

- NS is a signature that has historically been ignored in NER, but it contains valuable information about the neutron source term, especially the (α, n) component.
- The new tool may reduce degeneracy in an NER assessment.
- We determined it meets the practical count time and distance requirements for NER mission needs

TRANSITION PLAN

- On-going discussions with NER Program Management.
- If a fieldable sensor can be proven in the lab, NER PMs will support advancing the TRL beyond LDRD.
- Eventually, the goal is to submit the technology to the highly selective Pallet Process.



Typical NER deployment "pallet"

LDRD MFR Project: 20210548MFR

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